Atmospheric Electron-Induced X-ray Spectrometer (AEXS) Development

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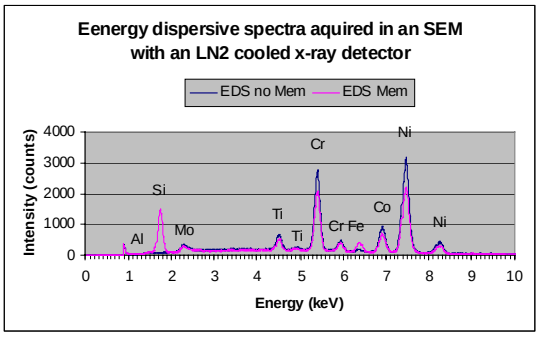
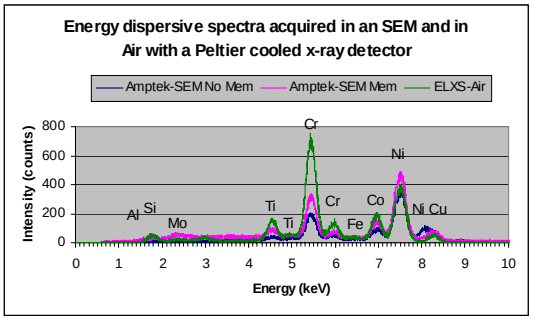
The AEXS is a miniature, low mass, low energy consumption, portable instrument for elemental surface analysis *in situ*, with high spatial resolution (sub mm-size) and short (~minute) spectrum acquisition times. The AEXS excites characteristic x-ray fluorescence (XRF) using an electron beam from samples in ambient atmosphere, requiring no sample handling; the excitation is made possible by isolating the vacuum of the electron column from the electron excitation is very effective in generating XRF, and a high intensity beam can be focused into a small spot. The rapidity of the spectrum acquisition (within minutes) and consequently low energy consumption (~50 Joules per acquired spectrum) will enable mapping the elemental composition of soil or rock surfaces in either a spot analysis mode (several 1 mm^2 irradiated spots), or in a survey mode (1-2cm^2 scanned area).

The AEXS, located on a rover or lander arm addresses the science needs of Mars Scout and MSL missions by providing a rapid means for elemental characterization of soil or rock surfaces. An instrument suite that includes a catholuminescence (CL) detector would permit to also detect CL spectra, thus being able to detect water-deposited minerals such as carbonates, which commonly exhibit CL. The AEXS also addresses the needs of a future MSR mission via its ability to rapidly screen potential samples for caching and return. The high flux of electrons could be used for ionizing gaseous species for further *in situ* analysis by other instruments such as mass spectrometers.





We report on our progress to date. Using an encapsulated 10 keV electron source, we have acquired XRF spectra from samples in ambient atmosphere, and compared them successfully with spectra obtained in an SEM using the EDS and Amptek detectors with and without the intervening membrane from several samples. Using a CL detector, we have obtained different CL spectra from different areas on silicate minerals, some of which were altered by microbial activities. The spectra were compared with EDS spectra analysis. To improve the excitation efficiency and reliability, we have adapted and vacuum-isolated a 20keV electron gun. The 20keV source is our baseline design for adaptation onto a rover arm, and is being used to acquire data in a vacuum chamber at Mars atmosphere pressure.